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Monitoring for Improved Pest Management

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Vince Matics, superintendent of Brook-Lea Country Club, Rochester, New York, looks on as an IPM scout searches for insects. Field seminars can be used to educate superintendents and support staff in monitoring techniques.

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A disease diagnostic lab is critical to the success of an IPM monitoring program.

Monitoring for Improved Golf Course Pest Management Results

by JAMES E. SKORULSKI
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PEST MANAGEMENT has become a major public policy issue today, affecting both large and small golf facilities throughout all regions of the country. This issue is debated passionately in certain states, but no golf course superintendent anywhere is free from public and golfer scrutiny when pesticide use and pest management practices are discussed.

Attitudes among superintendents concerning pesticide use and pest management issues have changed in recent years. It is not unusual to find superintendents scheduling pesticide applications in the pre-dawn hours to avoid conflicts with concerned golfers and neighbors. Notification laws have been instituted in several states, and it is likely that states will continue to enact more restrictions regarding pesticide availability and application. Course officials are even insisting that pesticide applications be made on specified days when the golf course is closed.

Are these policies the result of an irrational wave of public hysteria and extreme environmental activism, or is it long overdue, genuine concern based upon greater knowledge of pesticide issues? The answer, as it usually does, probably lies somewhere between these extremes. However, the intent of this article is not to examine this debate. Instead, it is to provide information about a sound program that will improve pest management results and possibly reduce pesticide applications.

It should be emphasized that an effective pest management program must begin with the turf's agronomic quality. A weakened or stressed turf is more vulnerable to disease, insect pests, and weed encroachment. The basic requirements for turfgrass have not changed. Adequate light, moisture, and effective drainage are three basic requirements for healthy turf.

Quickly consider which greens on your golf course require the greatest attention regarding pest management. More than likely they are perennially weak greens located among mature trees, or they suffer from poor surface or internal drainage. Simply removing or pruning trees or modifying drainage can dramatically improve the growing environment on these greens and reduce or eliminate many pest problems. The majority of Turf Advisory Service reports from USGA agronomists include recommendations concerning tree pruning and removal, yet these recommendations are often the most difficult to sell to course officials.

Improper water management, insufficient fertility, and excessively low mowing heights further stress the turf, leaving it more vulnerable to various pests and diseases. Several recent articles in the GREEN SECTION RECORD have discussed the importance of balancing the turf's fertility requirements and mowing limitations against practices aimed at providing championship playing conditions. This concept is especially important as play increases on many courses.

Water management also has been addressed in countless articles. Nevertheless, excessive irrigation continues as one of the greatest errors observed in the field.

Turf species selection is another factor that dictates pest management strategies. Introducing a species in an area outside its adapted range often results in stress that makes the turf more susceptible to pests. The use of creeping bentgrass in Florida is a good example of a grass species poorly adapted to the state's intense summer heat and humidity. From a pest control standpoint, architects and managers are advised to use grass species that are best adapted to specific regional conditions.

What other options exist to improve pest management results on the golf course? Trade and scientific journals discuss progress with biological and alternative control techniques. Plant breeders continue to work on improved turf cultivars, and new application equipment has been developed to improve our capabilities with a reduced environmental impact. Even with these advances, though, many feel it is too difficult to develop a field program that incorporates new technologies. Results from research and breeding programs hold promise but have yet to provide consistent field results that can be easily worked into existing programs. These new technologies are considered by some to be too costly or labor intensive for practical implementation. Finally, we have to ask ourselves to what extent we are willing to try new technologies and adopt new programs. It is difficult for many to change established practices that have been ingrained from formal education, practical training, and field experience.

The truth is, there are indeed low-risk programs and technologies that the superintendent can use for more effective pest management. The majority of these techniques are straightforward, common-sense practices that can be initiated even with a limited budget and staff. Let's take a closer look at one specific program that can be implemented to improve the results of your pest management program. In fact, it is currently in use at quite a few golf courses in the Rochester, New York, area.

The program is based on monitoring. Monitoring itself is not a new concept, of course, but let's look at a more structured monitoring program specifically designed for golf courses. The formalized programs are still in their developmental stages, but they already have improved pest management results and have reduced or eliminated some pesticide applications at many participating golf courses.

What Does a Structured Monitoring Program Consist of?

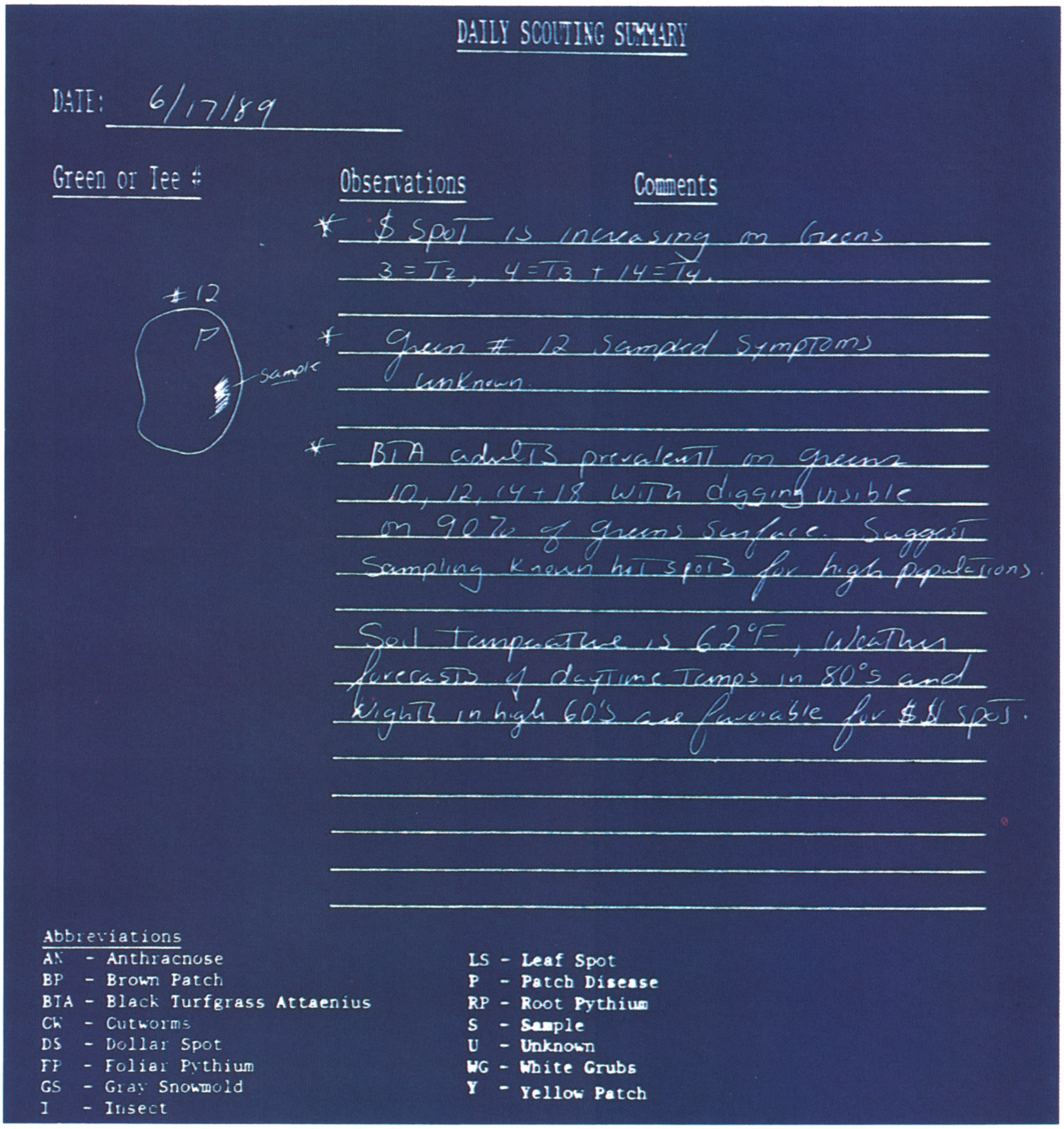
Essentially, a structured monitoring program uses designated scouts to collect a wide range of field data on the golf course. The information is documented and provided to the golf course superintendent in a formalized report that can be used as a basis for objective pest management decisions. The data include infectious and non-infectious symptoms observed on the golf course. Regular monitoring provides an excellent record of pest populations and their resulting damage, which can be used for future planning and program development. Regular monitoring also provides follow-up information on the success of a particular control measure against a pest.

The monitoring can be completed by a course employee who has formalized training in field diagnosis of weeds, diseases, and insects. He or she may have other duties to perform as an employee of the club, but the primary responsibility should be the monitoring program. The superintendent must avoid the temptation of assigning other work tasks that might disrupt regular monitoring practices.

A professional scout, who often is employed by several courses in a locale, also may be used to complete the monitoring program. Because they see several courses each week, professional scouts can spot trends in an area, and can use the information from one course's problems to assist the others. A scout is typically a graduate with a degree in agronomy or horticulture with emphasis in pest management. Students often serve summer internships as scouts, and then return following graduation as full-time scouts. The degree of education, field experience, and formal diagnostic training of a scout will influence the effectiveness and cost of the monitoring program. It was determined in the Rochester program that scouting greens, tees, and fairways weekly would cost each participating course approximately $3,000 per year.

How is a Monitoring Program Conducted?

An intensive program includes monitoring the greens, tees, fairways, roughs, and ornamental plantings and trees. Monitoring frequency varies for each portion of the golf course depending on the available time and operating budget. The greens and tees usually require the greatest attention and are initially monitored daily or every other day. Fairways and rough areas may be monitored less frequently if labor or time is a concern. Monitoring time can be reduced significantly once the indicator areas, or hot spots, for particular pest problems are found on the golf course. The superintendent can help provide guidance as to where such locations are for particular pests, and



DAILY SCOUTING SUMMARY

DATE: 6/17/89

Green or Tee # | Observations | Comments

\#12 P — sample

* $ Spot is increasing on Greens 3 = T2, 4 = T3 + 14 = T4.

* Green # 12 Sampled Symptoms unknown.

* BTA adults prevalent on greens 10, 12, 14 + 18 with digging visible on 90% of greens surface. Suggest sampling known hot spots for high populations.

Soil Temperature is 62°F, Weather forecasts of daytime Temps in 80's and Nights in high 60's are favorable for $ spot.

Abbreviations
AN - Anthracnose
BP - Brown Patch
BTA - Black Turfgrass Attaenius
CW - Cutworms
DS - Dollar Spot
FP - Foliar Pythium
GS - Gray Snowmold
I - Insect
LS - Leaf Spot
P - Patch Disease
RP - Root Pythium
S - Sample
U - Unknown
WG - White Grubs
Y - Yellow Patch

A typical scouting report used in the field contains pertinent information such as monitoring date, weather conditions, soil temperatures, and general comments on the turf's overall condition.

monitoring efforts can be concentrated in these areas when conditions favor those pests. Monitoring in the early morning hours is preferred, as disease symptoms and signs are most conspicuous prior to mowing. Scouting early each day also minimizes interference with play.

Monitoring greens and tees is completed simply by walking a circular pattern around each green to observe insect activity, weeds, disease, and noninfectious symptoms. The overall quality of the greens, tees, and fairways can be rated, and symptoms should be documented on a formalized scouting sheet. Pest activity may be quantified by counting actual insects, disease lesions, or weeds, or by estimating a percentage of affected or damaged turf.

Fairways often are scouted from a golf cart or utility vehicle. Closer examinations are completed if symptoms are observed. Scouting programs for certain pests can require a more in-depth procedure. For instance, evaluating late summer white grub populations requires a more specialized procedure which is completed separately from daily monitoring activities.

How Much Time Does a Structured Monitoring Program Require?

The time required to scout the entire golf course will vary depending on the time of season, pest activity, and degree of scouting. Initial scouting of greens, tees, and fairways has required approximately 3 to 3½ hours for formalized programs in Rochester, New York. The time requirement often can be reduced as the program becomes more refined. Obviously, the more time allotted to monitoring, the more successful the program. However, *The number of pesticide applications will change after initiating an IPM program. Sometimes the number will increase, but pesticides that are applied will be used at the most effective application period.*

managers and superintendents in the Rochester area feel that monitoring frequency could be limited to two or three visits per week without sacrificing the program's success. Several golf courses involved in the program are monitored even less frequently.

Nationally, monitoring frequency would be directly dependent on the weather conditions. Regions of the country with greater disease or pest pressure would probably require greater monitoring frequencies during periods of peak disease or insect activity.

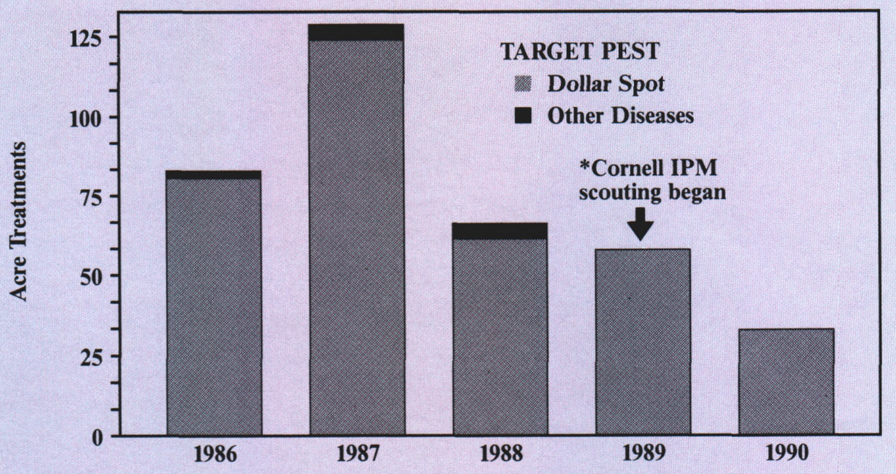
What Tools Are Required for a Monitoring Program?

The scout's tools are basically simple. A good set of eyes and an open mind are definite requirements. The scout also should be armed with a standard 10X hand lens, soil probe, cup cutter, pocket knife, tweezers, scalpel, collection vials, and field identification books. A 1-2 gallon diluted detergent solution also might be required for sampling thatch inhabiting and various weevil insects. Other permanent monitoring tools that would be helpful include a weather station, pheromone traps, and pitfall traps. These are permanent monitoring tools that might be stationed at each golf course.

How is the Field Information Packaged?

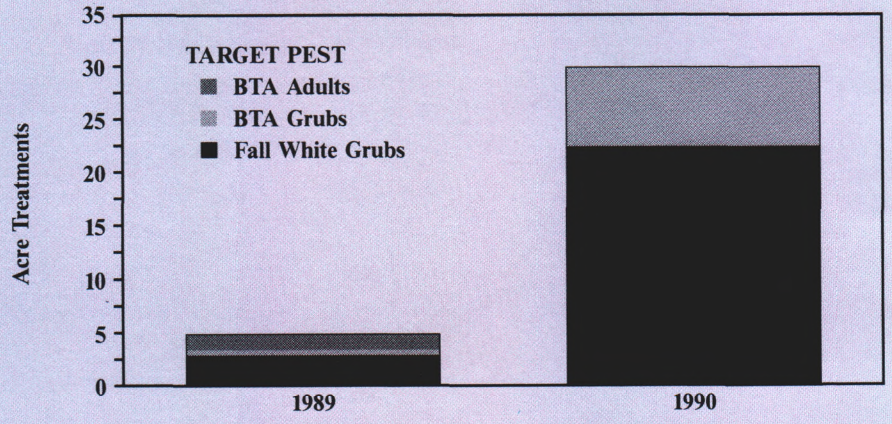
The field data are carefully tabulated on prepared field sheets that are provided immediately to the superintendent following the monitoring session. The information then can be logged into a computer to develop a permanent data base. Data sheets should contain as much pertinent information as possible. The monitoring date, weather conditions, soil temperatures, and general comments on the turf's overall condition can be listed along with the precise location and description of specific pests or symptoms encountered. Mapping pest activity, symptoms, or weed populations can be a valuable reference for the future. The data sheets can contain preformed diagrams of each hole, or the scout can sketch a rough drawing indicating the specific problem areas.

Total Fungicides Applied to Tees, Fairways, and Greens at Course #1



*Acre Treatment = Area Treated (acres) × No. of Applications

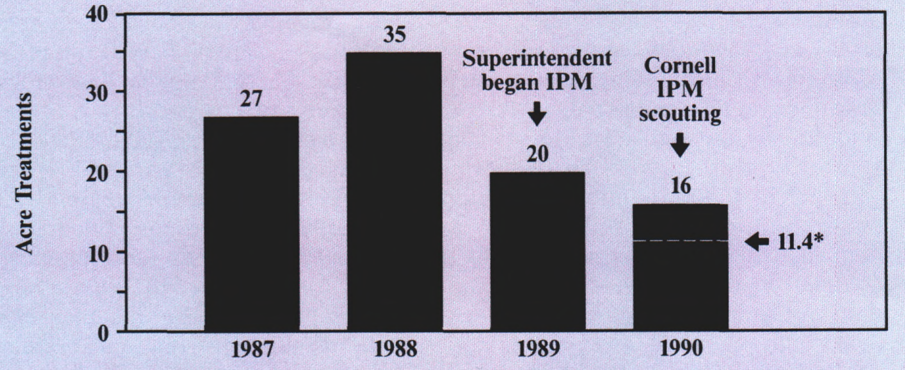
Total Insecticides Applied for Grub and Beetle Control at Course #1



BTA = Black Turfgrass Ataenius

Acre Treatment = Area Treated (acres) × No. of Applications

Total Fungicides Applied to Tees, Fairways, and Greens at Course #1



Acre Treatment = Area Treated (acres) × No. of Applications

*4.6 AT for Summer Pythium could have been avoided

What Are Some of the Actual Monitoring Techniques?

Specific monitoring practices vary depending on particular pests. Generally, disease symptoms and weeds are monitored visually. Insect monitoring may require excavation with a knife, cup cutter, or sod shovel, probing, trapping, or drenching. The scout should be fully knowledgeable with all monitoring techniques available for those pests that may be encountered. An excellent source of information for insect monitoring is *Turfgrass Insects of the United States and Canada* by Dr. Haruo Tashiro. It is available through Cornell University Press. Universities and extension agencies are excellent sources for information concerning diagnosis, biologies, and monitoring techniques for the specific pests in your region.

How Are Disease Symptoms Accurately Diagnosed?

The scout should be completely familiar with most disease symptoms in the field. There are many excellent books that provide in-depth descriptions of disease symptoms and epidemiology as well as descriptive color plates. The *Compendium of Turfgrass Diseases*, written by Richard Smiley and published by the American Phytopathological Society, is an excellent source of descriptive information and color plates (this publication currently is being completely revised). Slide sets of various diseases are available from universities and the American Phytopathological Society. Agri-Diagnostics Reveal Kits also are good tools for field diagnosis of specific diseases.

What About Diseases that Cannot Be Identified in the Field?

Many diseases cannot be diagnosed in the field. Microscopic examination is usually required for accurate preliminary diagnosis. Scouts should receive training in microscopic identification of disease pathogens, and they should be provided with a microscope or have access to a microscope and the laboratory supplies required for preliminary examinations. Additional laboratory diagnosis also will be required for some diseases.

Successful disease management depends on rapid, accurate field and laboratory analysis. It is imperative that a strong communication link be established between golf course personnel, scout, and diagnostic lab to assure timely diagnosis for effective control decisions. The success of a monitoring program often hinges on the superintendent's confidence in the scout and the laboratory's diagnostic capabilities.

What Benefits Result from Structured Monitoring?

Instituting a monitoring program improves pest management on the golf course. A monitoring program may not always reduce chemical applications in all situations, but it will assure more judicious use of pesticides. Trained personnel or professional scouts with access to a diagnostic lab are more apt to diagnose pest symptoms correctly, thereby reducing or eliminating improper or unnecessary pesticide applications. This system could result in a substantial monetary savings and possibly reduce the quantity of pesticides applied to the golf course.

A significant economic savings in labor and materials also has been realized during the initial years of monitoring programs completed on golf courses in New York State. The savings are calculated on pesticide applications based on structured monitoring versus applications completed on a preventative schedule. The initial savings have helped defray labor and diagnostic costs involved with the monitoring program. James Willmott, a principal investigator in the Rochester monitoring program, feels that scouting could be economically justifiable to clubs if pesticide applications were reduced by 40-50%. The reductions were a reality in the first years of the program, though this may not always be the case. Monitoring could, in fact, increase pesticide applications in some instances as more pests or pest symptoms are discovered from the greater monitoring intensity.

A structured monitoring program serves as the foundation for an Integrated Pest Management (IPM) program. Various IPM tactics can be used in control strategies should monitoring data indicate a need for action. Several years of compiled data will suggest pest threshold numbers specific to your conditions, which will further improve future control decisions.

Often, a monitoring program focuses attention on the areas of the golf course that perennially suffer specific pest problems. Management efforts or controls often can be concentrated in the indicator areas, thus avoiding broad preventative pesticide applications. Monitoring data can be used to limit pesticide applications only to those areas where pests are currently active. Detailed records and mapping also illustrate problem areas which may require cultural management changes or design modifications. Justification for such projects can be made easier with actual data that highlight the problem.

Obviously, structured monitoring is not the final answer to our pest management needs. Research is required to develop better forecasting models that can be used along with monitoring for more effective pest management. Research to obtain greater knowledge of pest biologies and life cycles, and pest response to various cultural practices also is required. Looking ahead, structured monitoring programs will begin to provide scientists with some helpful data concerning these needs.

Developing greater pest resistance in turf cultivars is another approach that needs more work. Plant breeders are currently working with naturally occurring endophytes in grasses and are attempting to expand this beneficial fungus into bentgrass, Kentucky bluegrass, and other turf species. Breeding work also continues to search for cultivars with greater disease resistance. For example, the USGA currently sponsors breeding work at Texas A&M University that is searching for Rhizoctonia brown patch and pythium disease resistance in bentgrass and zoysiagrass.

Finally, developments in alternative pest management techniques and biological controls promise to improve our capabilities. The production of host-specific pesticides and improved application equipment also offer promise for pest management programs in the future.

Combining these technologies with a structured monitoring program will form the basis for strong IPM programs. Pest management results will improve with no loss in turf quality or reasonable playing conditions.

Try initiating a monitoring program on your golf course and attempt to incorporate IPM control strategies with it. Perhaps you will surprise yourself or your course officials with a major reduction in the pesticide budget. You also might be surprised at the turf's ability to tolerate disease and insect pests. Finally, instituting a monitoring and IPM program will improve your image as a professional and demonstrate your genuine concern for the environment. After all, how many golf course superintendents don't consider themselves environmentalists?

Earthworms, Thatch, and Pesticides

by DANIEL A. POTTER,
Professor of Entomology, University of Kentucky

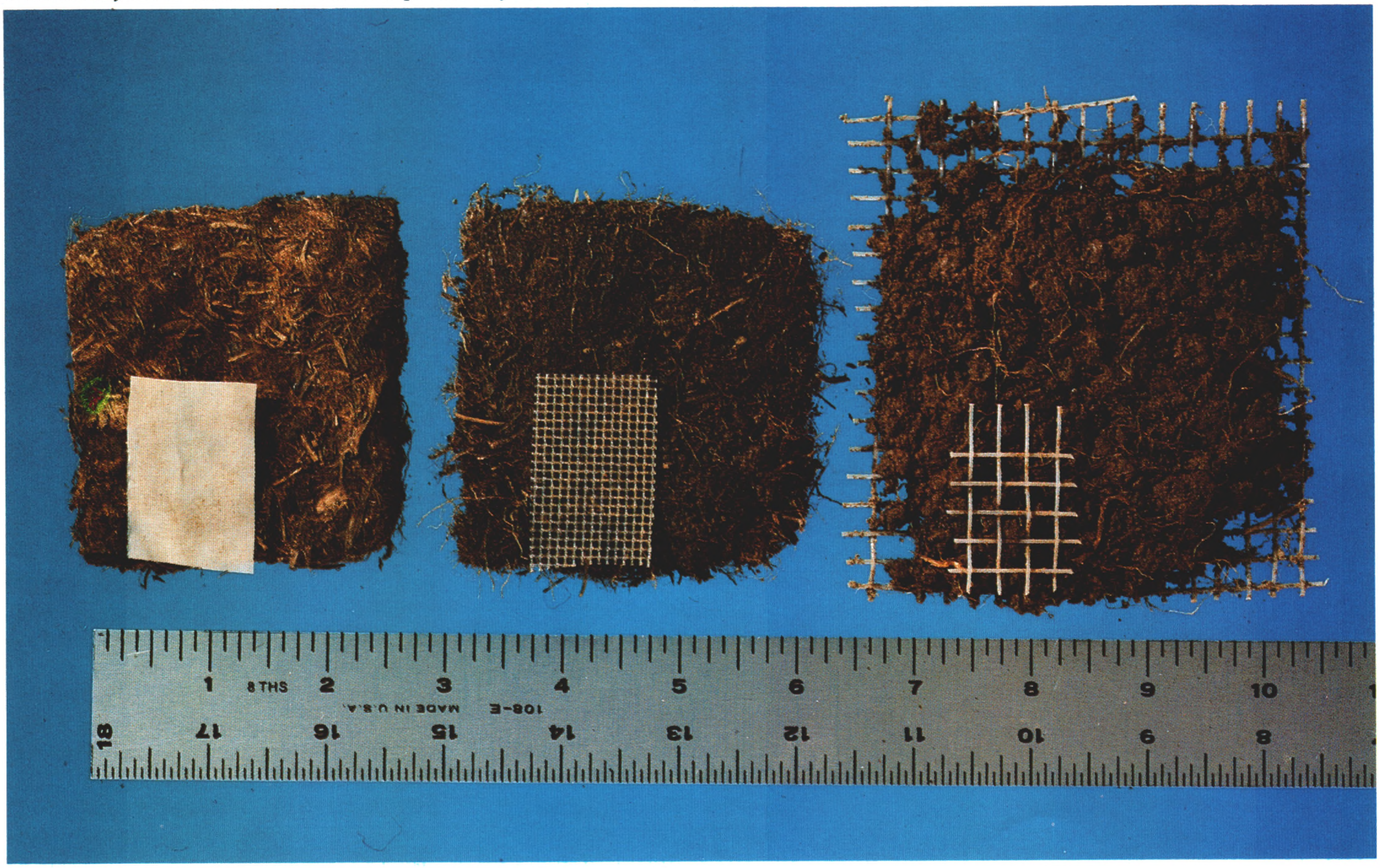
"The plow is one of the most ancient and most valuable of man's inventions, but long before he existed, the land was in fact plowed and still continues to be plowed by earthworms."
— Charles Darwin

EARTHWORMS are sometimes viewed as a nuisance by golf superintendents and turf managers because their burrows and surface casts disrupt the uniformity and smoothness of fine turf. Moreover, because earthworms and white grubs are regarded as a delicacy by moles, skunks, and other vermin, pesticide applications are sometimes made in the hope of reducing the food supply and causing the moles to go elsewhere. Thus, presence of a healthy earthworm population is viewed by some superintendents as more of a problem than a blessing.

My aim is to present the alternative viewpoint: that earthworms are extremely valuable components of the turfgrass community, and preserving their populations may be essential to the health and long-term stability of the turf. Recent research documents the role of earthworms in thatch breakdown, and also provides information on the relative compatibility of turfgrass pesticides with this process.

Role of Earthworms in Turfgrass

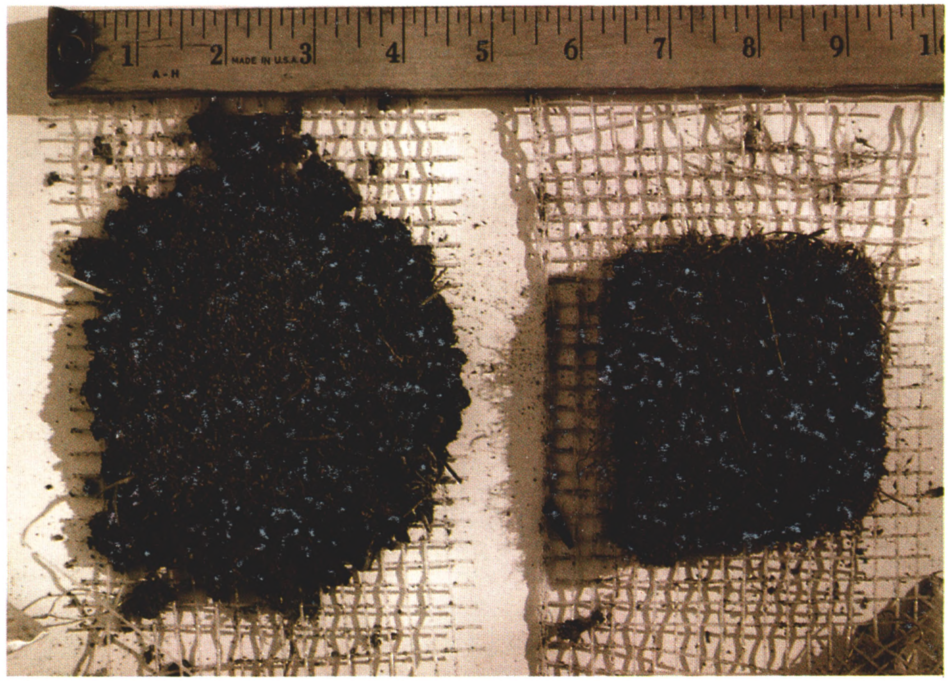
The Greek philosopher and scientist Aristotle called earthworms the "in-



Fine (left), medium (center), and coarse (right) mesh bags containing pieces of thatch were designed to selectively exclude or admit earthworms. After remaining buried 23 months, dramatically more mineral soil was incorporated by earthworm activity in the coarse mesh bag.

testines of the earth." Indeed, their importance in breaking down plant litter and nutrient recycling is well documented in forest and pasture soils. Earthworms mix organic matter into the soil, and help fragment and condition plant debris in their guts before it is further broken down by bacteria and fungi. Many studies have shown that plant litter decomposition occurs faster with the combined action of earthworms and soil microorganisms than with microorganisms alone.

Earthworms affect soil structure by their burrowing and casting activities. Two-thirds of the total pore space in soil may consist of earthworm tunnels. Earthworm activity is critical for air and water infiltration. For example, in one pasture experiment, the presence of earthworm burrows was shown to increase water infiltration rates two-and-a-half-fold relative to the same soil with no earthworms. Earthworms also mix the soil and enrich it with their castings, or excreta. Charles Darwin, better known for his theory of evolution, was an early expert on earthworms. His decades of painstaking research showed that as much as 18 tons of earthworm casts could be brought to the surface per acre per year, about equivalent to a uniform ¼-inch layer of enriched soil being deposited annually. Presence of earthworms has been shown to enhance growth and yields of grass in pastures.



Thatch pieces buried under Kentucky bluegrass turf for three months were more decomposed and dispersed in untreated plots (left) than in plots treated with insecticides (right).

Earthworms and Thatch

Thatch accumulations result from an imbalance between production and decomposition of organic matter at the soil surface. Excessive thatch can lead to long-term problems: reduced water infiltration, restricted penetration of fertilizers and insecticides, shallow root growth, and increased vulnerability to heat and drought stress. Thatch is often a problem in cultivated turf, especially when a high rate of nitrogen fertilization is applied for several years.

It generally has been observed that thatch is rarely excessive where earthworms are abundant, and previous studies have documented increased thatch accumulation following use of certain pesticides that are toxic to earthworms. However, until recently, the relationship between earthworms and thatch degradation had not been specifically studied. Understanding this process is important to thatch management. If earthworms contribute significantly to thatch breakdown, then turf management practices that are harmful to worms should be avoided when possible.

To resolve this question, two long-term studies were conducted at the University of Kentucky's turf research facility, near Lexington. Several hundred pre-weighed pieces of thatch, each about the size and thickness of a kitchen sponge, were sewn into nylon mesh bags and buried just beneath the surface of a Kentucky bluegrass turf. The first experiment used three different bags: fine mesh, to exclude all soil animals except microorganisms; medium mesh, to admit small insects and soil mites, but to exclude earthworms; and coarse mesh, to admit all components of the soil fauna, including worms. In a companion experiment, thatch pieces were buried in identical coarse mesh bags in either untreated turf or in turf that had been treated with certain insecticides to eliminate the earthworms.

Thatch pieces from each test were periodically dug up, reweighed, and analyzed for mineral soil content, microbial activity, and net loss of organic matter. Dramatic differences were apparent in both experiments after only three months. In the presence of earthworms, the thatch pieces were broken apart and dispersed. The worms incorporated large amounts of soil into the thatch, so that by the end of the experiment the earthworm plots contained 80% mineral soil by weight, versus 35% mineral soil without earthworm activity. Rates of thatch microbial decomposition were more than twice as high from plots with earthworms than where worms were physically excluded or eliminated with pesticides. The effects of this natural process are very similar to those achieved by coring or topdressing.

These experiments confirmed that earthworms play a major role in breaking apart and decomposing thatch, and in improving its physical and chemical properties for turfgrass growth. Preservation of earthworm populations is important where thatch is a concern.

Cross-section comparisons of an original thatch piece (top) and thatch recovered from medium (center) and fine (bottom) mesh bags, 23 months after burial. Decomposition was minimal in the absence of earthworms in the fine mesh bag.

these treatments significantly reduced the rate of breakdown of the buried thatch. Other insecticides, specifically isofenphos (Oftanol), trichlorfon (Proxol or Dylox), chlorpyrifos (Dursban), and isazophos (Triumph) caused less severe, but significant earthworm mortality. None of the tested herbicides or fungicides, other than benomyl, significantly harmed the earthworm populations.

In the long-term tests, Diazinon, Benlate, Sevin, Mocap, and Turcam were reevaluated in larger plots for a longer time period. The plots were 13 by 13 feet and treated at labeled rates once in May. Earthworms were sampled at 1, 3, 5, 20, and 46 weeks after treatment. Benlate, Turcam, Sevin, and Mocap had severe impact on earthworm populations, with reductions ranging from 40 to 77% still evident after 20 weeks. Thatch decomposition rates were significantly reduced. However, worm populations had recovered to near normal levels by the following April, approximately 11 months after treatment. We do not presently know how long it would take for earthworms to repopulate larger treated areas such as lawns or golf fairways, but population recovery at such sites would no doubt be slower than occurred in our study plots.

It should be noted that *none* of the compounds tested were registered for use against earthworms in turf. Furthermore, I am aware of no scientific studies that show that use of a pesticide to kill earthworms or white grubs will eliminate or alleviate a problem with moles. Although earthworms can be a nuisance on a golf course, their importance in aerifying and enriching the soil, enhancing water infiltration, and breaking down thatch is very beneficial to the long-term stability of healthy turf. I suggest that when a chemical application is needed to control weeds, pathogens, or insects, golf superintendents and other turfgrass managers would be well advised to select efficacious pesticides that are less toxic to earthworms.

Earthworms and Fertilizers

Excessive fertilization encourages thatch accumulation by increasing organic matter production and adversely affecting earthworms. Some fertilizers cause the soil to become more acidic (lower pH), which inhibits microbial activity. Earthworms also are intolerant of low soil pH, and are generally sparse in acidic pasture and forest soils.

In a recent test, we applied ammonium nitrate fertilizer to Kentucky bluegrass at varying rates for seven years to study the effects on earthworms, thatch, and soil pH. Application of 5 lbs. of nitrogen per 1000 sq. ft. per year for seven years resulted in a decline in soil pH (6.2 to 4.8), a 50% decrease in earthworm populations, and an increase in thatch accumulation of ¼ to ⅔ inch.

Earthworms and Pesticides

Other recent experiments at the University of Kentucky concluded that turfgrass pesticides differ markedly in their toxicity to earthworms, and some of the most frequently used products, when applied at label rates, can cause severe and long-lasting reductions in worm populations and reduced thatch breakdown.

During 1988 and 1989 we conducted four field tests to evaluate the short- and long-term impacts of 17 turfgrass pesticides on earthworm populations in Kentucky bluegrass turf. Thatch pieces were buried in the plots to see how pesticides affected thatch degradation rates. The plots, 6 by 10 feet, replicated six times, were treated with the pesticides in April, using labeled rates, and then irrigated with ¾ inch of water within 2 hours after the applications. Earthworm populations were counted 1 and 6 weeks after treatment using a dilute formaldehyde drench, which irritated the worms and brought them to the surface. The thatch pieces were dug up after 6 weeks and analyzed as described earlier.

The fungicide benomyl (Benlate), and the insecticides diazinon (Diazinon), carbaryl (Sevin), ethoprop (Mocap), and bendiocarb (Turcam) all dramatically reduced the earthworm populations. The latter three materials reduced populations by an average of 76-99% across two independent tests. All of

Acknowledgements: This research has received funding from the United States Golf Association, the O. J. Noer Turfgrass Research Foundation, and the U.S. Department of Agriculture. More detailed accounts of this research were published in the *Journal of Economic Entomology*, Vol. 83, pp. 203-211 (1990) and Vol. 83, pp. 2362-2369 (1990).

Learning to Live with Golf Cart Traffic

by CHUCK GAST
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GOLF CARTS have become an integral part of most golf course operations today. In more ways than one, they have made their mark at public, municipal, private, and resort courses throughout the country. While golf carts have done much to popularize the game of golf in this country, they also are the source of many headaches for the golf course superintendent. Since golf carts are here to stay, learning how to deal with the negative aspects associated with their use is essential in producing the best quality golf course conditions.

In 1990, the National Golf Foundation estimated that there were 800,000 to 850,000 electric and gasoline-powered golf carts in use on golf courses. Each cart was estimated to have made 150 rounds annually at an average rental fee of $14.00 per round, for a total of more than $1.7 billion in revenue. It further should be noted that this figure does not include income from trail fees from privately owned golf carts. Given these rather substantial income figures, the importance of this revenue producer to the golf industry is obvious. Furthermore, to add to this already impressive number of golf carts in existence, approximately 115,000 new carts are manufactured each year.

Other factors that lend credence to the use of golf carts on golf courses include enabling those with physical handicaps to play the game, as well as extending the number of years of play for many golfers. Use of golf carts also enables golfers to enjoy the game despite inclement or oppressively hot weather conditions and, in some cases, they actually assist in speeding up play.

Considering these benefits, it is safe to assume that carts are here to stay on the golf course. But consider some of the negative effects of cart traffic on the turf and soil. Even though a golf cart tire does not exert as much actual pressure on the turf as the human foot, golf cart operators tend to travel in similar patterns, resulting in accelerated turf wear and compacted soil conditions that limit turf recovery in these areas. During periods of turf dormancy, turf injury can be particularly severe, with little chance for improvement until normal turf growth resumes. This is a problem with warm-season grasses during the winter months and, to some extent, with cool-season grasses during dry, hot summers or very cold winters. Not only are effective management programs necessary to correct turf wear and soil compaction, therefore, but effective traffic-control methods also are necessary to minimize turf damage.

Problems of excessive turf wear and compaction are most noticeable in areas where traffic concentrates, usually near tees and greens or tight fairway areas. Loss of turf due to intense traffic conditions also can occur in other areas when adverse environmental conditions exist, such as drought stress or heavy rainfall conditions. While concentrated traffic on dry or frozen soil tends to cause turf loss due to physical wear, soil compaction is the greater concern when wet conditions persist. Programs ranging from intensive aerification to renovation with soil amendments to complete sodding sometimes assist in reestablishing acceptable turf conditions. Unfortunately, these improvements may only be temporary, and turf loss may occur again when similar environmental conditions return.

THE MOST efficient and logical approach to most problems is to correct the source of that problem. Effective traffic control, therefore, is essential to minimize the negative effects resulting from concentrated golf cart traffic. A variety of approaches have been found to be effective in providing improved turfgrass quality under high-traffic conditions.

Traffic injury near tees and greens often occurs despite the presence of cart paths. There seems to be a natural tendency for drivers to pull their golf carts off the edge of the path, as they would when pulling their cars off to the side of the road. This causes a gradual deterioration of the turf adjacent to the path, and the area soon becomes a mudhole awaiting the brand-new golf shoes of the unsuspecting, recently elected club president.

This situation can effectively be avoided by installing curbing along the paths in these potential wear areas. Installation of four- to six-inch curbing during initial path construction, using the same material, be it concrete or asphalt, works well and presents a neat, uniform appearance. When adding curbing to existing concrete cart paths, concrete curbing can now efficiently be installed (in areas of the country where it is practical) utilizing a one-step curbing machine. Typically, however, curb additions to existing paths are made with treated wood timbers or railroad ties.

With any curbing method used, the most important point to remember is to backfill the turf side to the top of the curb. Attention to this detail provides a cleaner look and allows for easier maintenance in these areas. Furthermore, the tendency to trap water on the turf side of the curb is eliminated.

To minimize turf wear and compaction throughout the fairways and roughs under intensive traffic conditions, installation of a continuous cart path system has proven to be the best solution in many parts of the country. At facilities that average more than 30,000 to 40,000 cart rounds annually, continuous golf cart paths are essential for maintaining healthy turf and good course conditioning. A continuous path system also allows the use of golf carts, restricted to paths only, during excessively wet conditions when carts might not otherwise be permitted on the course. Loss of revenue is thereby averted, too.

(Opposite page, top) One-step concrete curb installation machines allow quick, efficient curb installation for effective traffic control.

(Opposite page, bottom) Cart paths ending in a balloon shape in combination with movable flower containers create an aesthetically pleasing method to effectively distribute golf cart traffic.

(Left) Entry and exit areas of partial cart path systems typically exhibit excessive turf wear conditions.

During more favorable soil moisture conditions, a continuous cart path system allows implementation of the 90-degree rule. Adherence to this rule effectively minimizes concentrated wear patterns by distributing traffic throughout the entire length of the fairway. Also, an eight-foot-wide continous cart path system provides an effective pathway for the daily travels of maintenance equipment.

On courses where continuous cart paths are neither feasible nor desired, wear areas are a common occurrence at the entry and exit points to cart path sections. At the fairway entry point coming from the tee, the cart path should end in a balloon or fan shape, or should lead away from the fairway into the rough area. This allows carts to exit from the path at many points to better distribute traffic flow and minimize turf wear. Where straight paths already exist, ropes, signs, or other physical barriers can be used to force carts to exit the path at selected locations.

At Lakewood Country Club, in Denver, Colorado, an effective and aesthetically pleasing method of distributing traffic involves the use of planters. By constructing planters using lightweight materials, it takes just a single worker to move the planters to desired locations. These planters are both functional and attractive for the members of this club. Also, utilizing small plant containers within the large planters allows older, less attractive flowers to be replaced easily with new material.

TO CONTROL and direct traffic flow around green complexes, use of ropes, painted lines, or signs across the fairway can be effective but may require added labor for moving ropes and signs or repainting lines every time the fairways are mowed. Also, a painted line across the fairway can be a disadvantage during periods of slow fairway turf growth, resulting in excessive wear from the inability to relocate this line as often as necessary.

An alternative and effective method of traffic control in this area involves the use of a 4″ × 4″ post with a spike base. This fairway exit point indicator at the edge of the rough can be easily moved as necessary to prevent excessive turf wear. On occasion, a directional sign can be utilized to emphasize the intent of this marker post.

In summary, there is no doubt that the golf cart has become an important factor in today's golf industry. The revenue produced on an annual basis allows many public courses to maintain reasonable green fees. Equally important, golf cart income is extremely beneficial in maintaining a favorable "bottom line" at private clubs and resort courses. Additionally, for many golfers, the golf cart provides added enjoyment to the game and extends the number of years they can play.

Since golf carts are here to stay, traffic management must be viewed as a basic aspect of routine course management. Through the implementation of effective traffic-control practices, the golf cart and the golf course can better exist in harmony and make the ever-increasing traffic on today's golf courses easier to live with.

Drainage — The Sometimes Forgotten Necessity

by DICK NUGENT
Dick Nugent Associates, Long Grove, Illinois

DURING a recent tour of British golf courses, I was told, "You Yanks take a well man and make him sick!" That was their picturesque way of saying we use too much irrigation water, make the grass sick, and then we apply pesticides and even more water.

Irrigation has been a favorite topic of the golf course maintenance industry during the last 20 years. Applying water to the golf course is the conspicuous, perceptible part of turf maintenance. But the other side of that coin is drainage — getting water *off* the golf course. Drainage is the hard job, the thankless job, the job nobody wants to talk about.

Drainage is not only crucial to quality turf maintenance, it also affects the playability of a golf course. A properly designed and installed drainage system keeps the golf course dry and playable, providing more playing time than a non-drained course. A drained course has the added advantage that it can be played more often with carts — no small consideration.

Rx for Turf Health

Ideally, the combination of drainage and irrigation achieve a soil condition agricultural engineers call "field capacity." This is the ideal level of moisture that, when balanced with air, enables aerobic bacteria in the soil to complete the nitrogen life cycle, thereby supplying nutrients to the grass.

Drainage can lower the water table, allowing the top part of the soil to dry out. This fosters grass root development, especially during the spring when the water table is normally near the soil surface. The deeper roots break up the subsoil and help develop good soil structure. Drained soils also warm more quickly during the spring season, promoting turf growth and speeding winter recovery. Conversely, drained soil is less apt to suffer from freezing damage.

In parts of the United States where soils contain a large amount of salt, sufficient irrigation is needed to flush the salts from the turf root zone. Drainage is especially important in these soils to allow this maintenance practice to occur. Adding fertilizers, which are basically salts, can create a similar situation if inadequate drainage exists.

System Components

There are a variety of drain types available, including tile drains, French drains, and open ditch drains, as well as storm sewer systems.

The least expensive to install is the open ditch drain. This type is frequently used in Great Britain, even at the exclusive Sunningdale Golf Club near London. In the United States, open ditches often are used on land of low value, such as swamps and forests, where more sophisticated drainage systems would not be cost effective.

Open ditches are relatively inexpensive to construct, but they do require long-term maintenance, including the removal of weeds and sediment. They are difficult to mow, and maintaining the slopes without the sides collapsing can be a problem. Also, there is the need to dispose of the excavated soil during construction. Although open ditches are not the optimum drainage solution for a golf course, there are occasions when physical conditions do not provide adequate slope or cover for drain pipes, and an open ditch may be the only reasonable option.

A variation on the open ditch drain is the French drain, consisting of a narrow open ditch drain filled with gravel. A disadvantage is the tendency for the upper portion to become sealed with dust and surface soils, which eventually clog the drain. To alleviate the problem, a geotextile fabric can be used to line the bottom and sides of the trench. When the gravel is in place, the fabric edges are overlapped over the top of the gravel. The fabric holds the gravel in place and, in unstable soils, prevents soil fines from entering and clogging the drain. The top can be cleaned off periodically or simply sealed off with a layer of porous soil or sand. Today, French drains are rarely recommended.

Historically, tile drains were constructed with 4-inch-diameter, 12-inch-long pieces of concrete or clay tile. Corrugated polyethylene plastic tubing, which is resistant to damage by acid soils and frost, is now a popular substitute for concrete or clay tile. The corrugations strengthen the tubing, which is manufactured in continuous lengths ranging from 500 feet for 2-inch-diameter tubing, to 20 feet for 8-inch or larger tubes.

Although tile drains are somewhat more expensive to construct, they provide a system that functions well over the long haul, with minimum maintenance. While it is true that soil fines and sand can enter the tile or tubing, the flow of water should carry the deposits along, preventing clogging of the system.

Although a variety of materials can be used as an "envelope" around subsurface drains to prevent clogging, the most commonly used is gravel, sized ¼ inch to ⅜ inch. The envelope material functions as a filter for fine sands and silts from the inflowing water.

Interceptor Drains

There are occasions when hillside surface water must be dealt with to prevent erosion and subsequent pond-

Inadequate drainage on this approach has created an unplanned hazard. A properly designed and installed drainage system is crucial to keep the golf course dry and playable.

ing in low areas. Hillside seepage occurs when previous surface soil is underlain with impervious soil that restricts vertical water movement. Hillside seepage also occurs when a water table exists at the soil surface, usually at the intersection of a hill and a flat valley. For example, seepage may occur where an elevated green meets the surrounding land. By locating a subsurface interceptor drain uphill from the wet area, water can be intercepted and carried away.

Storm Sewers — A Plus

The best outlet for a quality drainage system is a storm sewer system. While golf course drainage systems often do not tie into storm sewer systems, they should whenever possible. This should be a major consideration for a quality golf course drainage layout.

Storm sewers usually have two types of maintenance access: manholes and catch basins. Manholes should be placed at any point where a drain line changes direction, but no farther than 300 feet apart. Manholes have a covered top and a smooth bottom that matches the flow line of the drainage tile connected to it. The catch basin has an open, grated top to allow drainage to flow into it from the top, as well as from drain tile entering above the bottom of the basin. Since the flow is uninterrupted in a manhole, soil deposits do not accumulate. However, in the catch basin, the space between the tile and the basin bottom can fill up with drainage solids, so it must be cleaned out periodically. For easiest maintenance, it is best to run your drainage to a storm sewer system that features only manholes.

There have been cases where drainage water has been recycled for use in the irrigation system. Pete Dye's design for the Old Marsh Golf Club in Florida is a case in point. There the water is recycled to avoid contaminating the natural ecosystem of the Everglades. The drainage water is collected and taken to sumps, where it is pumped into a storage lake until needed for irrigation.

Recycling is an expensive solution, but it is a viable answer. With recycled systems, the more the water is reused, the more concentrated the salts can become. Because of this, the water must be diluted occasionally.

Drainage System Layouts

Drainage systems are identified by their layout patterns.

The flag pattern, also known as the parallel system, is used to drain areas that have uniform slopes. A series of sub-branch lines, or laterals, run parallel to each other and drain into a main line. Drainage installers must do a good job of setting the lateral lines to an established pitch that must remain constant for the system to perform properly. Maintaining a constant pitch can be difficult if the terrain is uneven.

The herringbone system is used to drain swale areas. Water flows in the laterals toward the main line, located in the lowest part of the swale. This system is frequently used because of the ease of its installation.

The natural layout, as its name suggests, follows a pattern dictated by the low areas of the golf course, draining the water away from the low points to a main line.

Line spacings for the drainage system are determined by the "pulling distance" or the area from which the tile can effectively pull water. The pulling distance is determined by the drain tile depth and the soil type. In heavy clay soils, it may be necessary to place the laterals as close together as 30 to 40 feet for proper drainage. In light, sandy soils, the laterals may be as much as 200 feet apart. In general, the wider the spacing, the deeper the drains are placed.

Air Vents Helpful

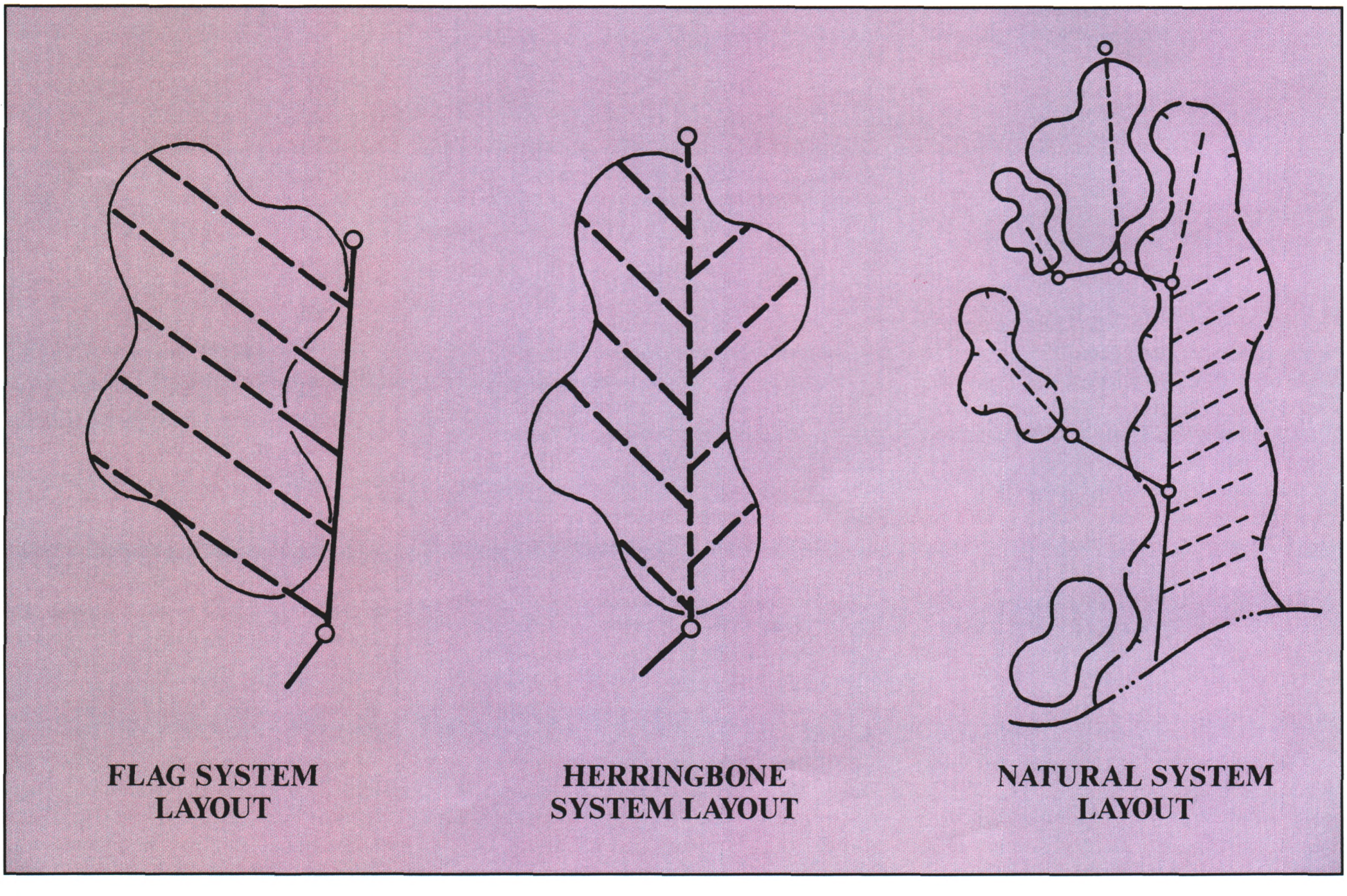
Our experience has taught us to place an air vent riser at the high points of the tile lines. A few years ago, we ran into a problem of water standing in the cup of a well-tiled green, yet no water was coming out of the drain tile. We discovered that heavy soils had clogged the drain, causing a suction, much as you get when you put your tongue on the end of a straw in a glass of soda pop. As long as you keep your tongue on the straw and don't break the suction, you can lift the straw without the soda running out. So, sure enough, as soon as we opened up the tile at the high point of the green, the water went gushing out of the tile. Since then, we have generally made it a practice to introduce an air vent at the high points of drainage lines.

The air vents accomplish three things. First, they prevent the suction from occurring. Second, they provide convenient places to introduce water into the system if flushing is needed to clear a blocked tile. And finally, the vents introduce air into the tile line, which helps to aerate the soil.

Common Sense and Drainage

Thinking about what it takes to achieve an outstanding and playable golf course, I am reminded of the story about the farmer who, every year, had the most outstanding crops in his area. His neighbors finally asked him to meet with them and share his secret. "Well," he replied, "the way I look at it, there's really not much to farming. It's about 90 percent drainage and about 10 percent common sense. If you don't have much common sense, put in more drainage!"

That story applies handily to golf courses. The secret of a great golf course is good turfgrass. One of the secrets for growing good turfgrass is good drainage. So if you want a great golf course, you'd better pay attention to your drainage!



Pond Vegetation from a Positive Perspective

by NANCY P. SADLON
Environmental Specialist,
USGA Green Section

Photograph by DAVE WEDUM

Whitefish Lake Golf Course, Whitefish, Montana.

GOLF COURSES have a long history of struggling with accelerated weed growth in golf course waterways and ponds. Establishing a balance is a key concept in maintaining a healthy pond system and also an important concept in integrating wildlife and natural areas of the golf course with the game of golf.

A pond's natural aging process, known as natural succession, refers to the transition of an open water system to a marsh and, ultimately, an upland. Mother Nature intends for this process to take centuries, but nutrients introduced into a waterway can shorten this process to a few years. To create a balanced pond ecology, it is important to eliminate any additional nutrient loading to the pond. Many golf courses have problems when surface water drains directly into water bodies, adding increased levels of nutrients to the pond and stimulating excessive growth of aquatic plants and algae. The result for the superintendent is war against excessive growth and the perception that all pond vegetation is the enemy.

Aquatic plants play an important role in the health of a pond and have many positive attributes. They have essential functions, which include:

- The production of oxygen, from photosynthesis, to aerate the water.
- Providing shelter for fish and freshwater invertebrates.
- Strengthening the river bed and banks.
- Providing a spawning medium for many fish.
- Supplying food for aquatic organisms.
- Use of emergent plants as nesting sites and a food source by waterfowl.
- Filtering pollutants and nutrients.
- Adding aesthetic appeal.

As a first step towards a balanced pond system, try to minimize the additional nutrients found in surface drainage from reaching the pond. Using a filter, such as a swale or gravel trench, around the receiving edge of the pond to intercept surface flow, and establishing vegetation as a buffer strip, can begin to reduce the nutrient load. Buffers can include a variety of vegetation types from grasses to trees, and they provide additional value as food and cover sources for wildlife.

Species of edge plant materials that like their feet wet are referred to as emergent plants. Suggested species for use in ponds include arrowheads, bulrushes, sedges, duck potato, pickerelweed, and rice cutgrass. These plants should be planted in 6-to-12 inches of water. Most emergent plants can be planted any time during the year, as long as the water requirements are provided. Plants with dormant tubers, such as duck potato, should not be planted during their dormant growing season.

An alternative includes using border shrubs, usually multi-stemmed, woody plants found on the edge of the pond in areas that are flooded only periodically. Suggested species include: buttonbush, alder, bayberry, chokeberry, serviceberry, pussy willow, and common winterberry. These plants are best suited to the drier edges of the pond above the water line. Contact your local nursery for species availability and zone hardiness.

Although a vegetation buffer surrounding all sides of the pond would provide the best nutrient filter, this usually is not an acceptable solution when the pond is a water feature that comes into golf play. The solution involves a balanced approach, including the establishment of a grassed swale for those areas in play, with the out-of-play areas of the pond planted with border shrubs and emergent plants. This compromise provides for the health of the pond, the play of the hole, the aesthetics of the view, and the proliferation of the area's wildlife.

When reviewing your annual budget for the war against aquatic weeds, consider this common-sense approach to creating a balanced pond ecology. This simple project represents a positive conservation approach. Encouraging beneficial plant species around the pond can filter nutrients and reduce your dependence on chemical controls at a later time.

BORDER SHRUBS[1]	Ornamental Value	Cover/Nesting Value	Food Value	Waterfowl	Upland Game Birds	Other Mammals	Songbirds	No. Bird Species Utilize	REMARKS
Alder, Speckled *(Alnus rugosa)*	●		●				●	15	Seed source for goldfinches, pine siskins; winter food source.
Bayberry, Northern *(Myrica pennsylvanica)*	●	●	●				●	26	Red-winged blackbird nesting.
Buttonbush, Common *(Cephalanthus occidentalis)*	●	●	●	●				7+	Food source for waterfowl; flowers used by ruby-throated hummingbird.
Chokeberry, Red *(Aronia aorbutifolia)*	●	●	●				●	12	Berry food source; fall color interest.
Dogwood, Silky *(Cornus, amomum)*	●	●	●				●	18+	Berry food source; fall color interest.
Serviceberry, Shadblow *(Amelanchier canadensis)*	●		●				●	36	Berry food source.
Willow, Pussy *(Salix discolor)*	●	●	●		●	●	●		Showy fruits; grouse eat buds; American goldfinch nesting site.
Winterberry, Common *(Ilex verticulata)*	●	●	●				●	7+	Berry food source thru winter; attractive to mockingbird, cutbird, brown thrasher & hermit rush.

EMERGENT PLANTS[2]	Ornamental Value	Cover/Nesting Value	Food Value	Waterfowl	Upland Game Birds	Other Mammals	Songbirds	No. Bird Species Utilize	REMARKS
Arrow arrum *(Petrandra virginica)*	●	●	●	●					Seed eaten by wood duck and other waterfowl; clump plant that does not spread, statuesque.
Arrowheads, Duck Potato *(Sagittaria species)*	●		●	●				19+	Most valued for underground tuber (potato); favored by waterfowl species, including the canvasback, black duck, godwall, wood duck, ringneck duck, trumpeter, whistling swans, sandhill crane, king rail.
Bulrushes *(Scirpus sp.)*	●	●	●	●		●	●	30+	Seed is important food source for ducks, marsh birds, and songbirds, including swans, cranes, godwits, rails; stems and rhizomes eaten by muskrats and geese. Upright stems good cover for nesting waterfowl, marsh wren, bitters, coots, grebe, red-winged blackbirds. Valuable for controlling shore erosion.
Iris, Yellow Water Iris, Blue Flag *(Iris sp.)*	●		●		●				Yellow or blue flower of ornamental interest; limited wildlife value; muskrats eat roots.
Pickerelweed *(Pontederia cordata)*	●		●	●				6+	Slow spreading with bright blue flower spines, excellent color accent in pond; seeds eaten by black and wood ducks.
Rice Cutgrass *(Leersia oryzoides)*			●	●	●		●	14+	Seed and roots important to waterfowl.
Sedge species *(Carex sp.)*	●	●	●	●	●		●	53	500 species of sedges; clump grower; excellent nesting; seeds important food: teals, rails, grouse, snow bunting, larkspur, and swamp sparrow.
Sweet Flag *(Acorus calamus)*	●	●							Ornamental interest, non-spreading clump plant, limited wildlife value.

[1]Plants prefer periodic flooding. Should be planted on pond banks, above normal water edge. Height ranges from 5 to 20 feet.

[2]Plants grow in shallow water and prefer wet conditions. Planted in 6 to 12 inches of water. Height of these herbaceous species ranges from 2 to 4 feet.

*Contact a local nursery regarding availability and zone hardiness.

A vegetation buffer not only provides aesthetic beauty but also strengthens the pond banks.

ALL THINGS CONSIDERED

The Game of Golf Is Played on Grass

by STANLEY J. ZONTEK
Director, Mid-Atlantic Region, USGA Green Section

WHEN the golf course is in good shape, everything at the club seems to go well. How obvious . . . or is it?

Why is it, then, that today's golf course superintendent must compete — perhaps struggle is a better word — for the machinery, manpower, materials, and "the budget" to do his or her job? Sometimes clubs and courses appreciate the obvious. If the golf course is in good shape, the rest of the facility hums. People bring guests who pay guest or green fees. This factor impacts favorably on the food and beverage portion of the club, and it helps the facility's cash flow. Members and guests buy logo shirts and sweaters, benefiting the golf professional. Everyone is happy and the club or facility is healthy.

Consider what happens, though, when several greens or fairways are lost, tees are divoted and devoid of turf, the roughs and stream banks are not well cut, and trash, tree limbs, and litter are scattered about the course. Who is happy then? Would you bring guests or sponsor business outings at your club or course? Probably not, or only with a multitude of apologies and excuses.

With less play, food and beverage sales suffer and golf carts go unrented. Golf shirts remain on the shelves and everyone begins to grumble. Attention is then focused on, you guessed it, the golf course superintendent.

Do you think a golf course superintendent wants to present a shabby golf course? Is that individual, as a professional, pleased with what he or she sees out there? No, not in the least. So why does it happen?

I submit it often is a question of budget priorities. *The golf course is not getting its fair share of the golf course income.*

Specifically, what percentage of course income is being used to maintain the golf course? Do you think it is 20%, 33%, or 50%?

Figure it out. If the club has an income of, say, $2 million per year and the golf course maintenance budget is $400,000 per year, then the maintenance budget is 20% of the entire club or golf course income. Twenty percent does not sound like very much, and often it isn't enough. Where is the other 80% going?

Shouldn't it be a goal to allow the golf course to be maintained at a level where all the departments are humming and everyone is happy?

Only you can know. It bothers me that golf course maintenance budgets often do not receive their fair share of the club income, and when the course is not perfect, the superintendent is criticized. I submit the real culprit is the budget policy — not providing what is needed to do the job well.

Perhaps a better sales pitch is needed. I hope these comments will help people realize the obvious . . . the game of golf is played on grass, and providing properly for its maintenance should be a course's number-one priority.

TURF TWISTERS

HOW'S THAT AGAIN?

Question: Over the past ten years we have experienced very good germination on our bermudagrass greens with our winter overseeding program. However, during the three to six weeks following seeding, we experience a rapid decline in stand density. I am only allowed two weeks after seeding to maintain the elevated mowing height at ¼ inch. The membership objects to the "shaggy and slow" putting surface, and it is necessary to reduce the mowing height of the greens back to 3/32 to 3/16 inch. Is the quick reduction of the mowing height the cause of the loss of stand density that we've experienced? (Florida)

Answer: More than likely it is. Reducing the mowing height too quickly on an establishing turfgrass can result in a loss of stand density. At least ¼ inch mowing height must be maintained for four to six weeks after seeding to allow good seedling establishment. This is particularly true when extremely warm daytime and nighttime temperatures persist during establishment. Explain to your golfers that an elevated mowing height during establishment is critical to obtain the best possible winter greens.

ADD NEW VARIETIES

Question: Following construction of our USGA spec greens, they were established with Penncross creeping bentgrass. Now that several new varieties have been released, should we select one for overseeding instead of Penncross? If so, is there any potential for segregation and a subsequent reduction in putting quality? (Washington)

Answer: Research studies have shown the newer creeping bentgrass varieties to have improved heat, drought, and disease tolerance. It would be to your advantage to introduce some of the newer bentgrass varieties via overseeding. In regard to a possible decline in putting quality, it is unlikely that individual plants will noticeably express themselves in terms of color, texture, and/or growth habit, that would affect putting quality.

TO MAXIMIZE YOUR RETURN

Question: The school terms in this area now extend from Labor Day well into June, so our normal seasonal labor supply is not what it used to be. What source is being used at other courses? (Iowa)

Answer: Look to retirees! There are many people in their late 50s and 60s willing and able to help out. They take instruction well, enjoy the early morning work, prefer seasonal employment, and often outwork many of the younger set. Those who play golf have the added advantage of having some idea of what you are trying to achieve.